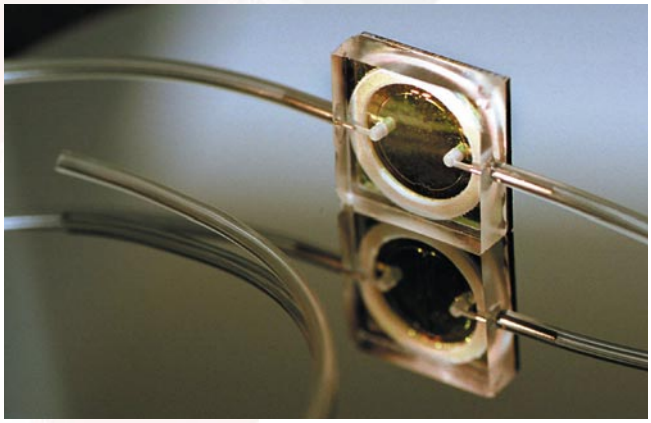
DETECTION & ANALYTICAL SYSTEMS



Sandia's biocavity microlaser. The nanoloaser, and microfluidic channels, also developed at Sandia, are too small to see without a microscope.

Biocavity Laser

Sandia has created a biological microcavity where biological cells form part of a semiconductor laser and impress cell information on the laser's optical output. Specifically, the spectral emission of the laser is very sensitive to the protein content of the cell. The mode pattern is also sensitive to the protein distribution in the cell. Using both sets of information, the device is able to distinguish cancerous cells from normal cells. It is anticipated that the bio-cavity laser will be used for rapid and relatively noninvasive medical diagnostics.

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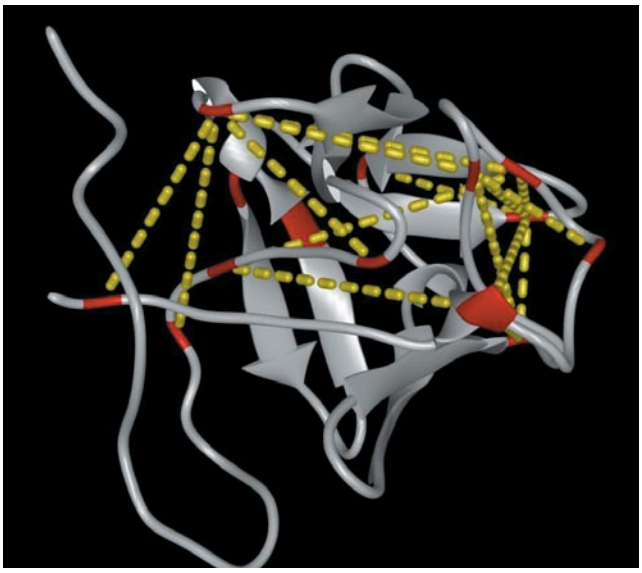
Biomolecular Materials & Interfaces

Biological science has entered a new post-genomic phase in which the focus is to determine the structures and functions of proteins, the DNA-encoded "workhorses" of the cell. Sandia is developing a unique technology, called MS3D, for probing the structures of membrane-bound proteins that are responsible for cellular signaling. The technology is a synthesis of state-of-the-art protein crosslinking, proteolysis, mass spectrometry and modeling approaches. The MS3D approach has the potential to rapidly probe the structures of membrane proteins and derive information about their function. Such information can be used to determine important information about biological processes with strong ties to national security such as biotoxin binding and action.



Application of MS3D to the soluble protein target FGF-3 resulted in 18 crosslink derived distance constraints (in yellow). These distance constraints, used in conjunction with modeling approaches, were sufficient to build a model of the FGF-2 3D structure.

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Early Disease Detection

The threat of biological terrorism has introduced an entirely new aspect to weapons of mass destruction. Assessment of human exposure currently relies on pathogen replication or host responses using tests that can take from days to weeks. A collaborative DARPA-funded project between Sandia and the University of New Mexico Department of Pathology is developing methods to rapidly detect the onset of infection. Infrared data, combined with state-of-the-art multivariate analysis tools, are being used to quickly delineate cells presenting an infection-like response from healthy cells.

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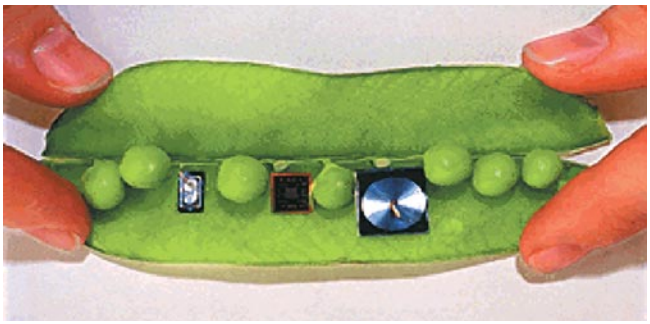
Micro Total Analysis Systems

MicroChemLab™ technology is targeted at the growing and increasingly important class of problems requiring rapid detection and identification of minute quantities of chemical compounds in the presence of large quantities of



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background materials. Towards this goal, Sandia has miniaturized general-purpose gas and liquid chemical separations systems. The analytical methods needed to use these systems for the identification of a broad range of chemical agents are in development and prototype instruments are entering field trials. To date, gas phase analysis has principally focused on volatile small molecules, with most work directed at analysis of chemical warfare agents and toxic industrial chemicals. Liquid analysis separation of other types of biomolecules including protein toxins and bioregulators has been demonstrated. Methods to detect pathogen signatures are currently under development. Chemical analysis with these systems is fast, very sensitive, and selective.

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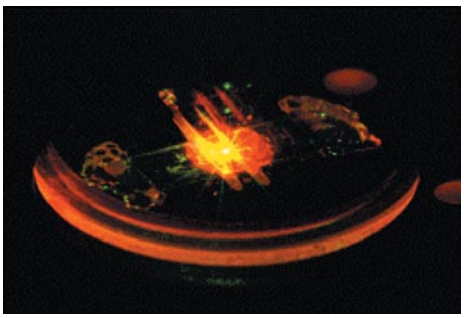
DNA Detection Sample Processing Technologies

Basic building blocks can be fabricated using the standard SUMMiT technology. Sandia can provide technology for



This vertical cavity surface emitting laser (VCSEL) device can produce information about the state of millions of cells in a few minutes.

value-added biochip production, including advanced printing and scanning, analysis software, optics, and other aspects of biochip instrumentation. Sandia's superior microelectronics capability can help integrate any system.

Sandia researchers, with industry partner Cielo, Inc., recently developed the first 1.3-micron electrically pumped vertical cavity surface emitting laser (VCSEL) grown on gallium arsenide. This particular device will be used in a data communication capacity. In the biotech area, Sandia

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is currently working with a number of partners, including a gene sequencing project with Harvard University and the development of a next-generation gene chip microarray scanner with the University of New Mexico Cancer Center.

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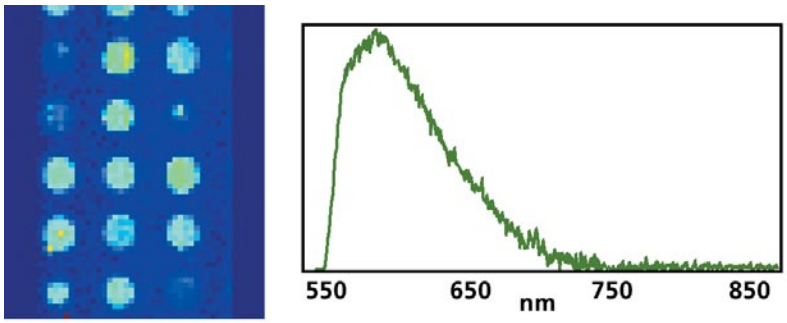
Hyperspectral DNA Microarray Scanner

One of the more powerful technologies in biology today is the DNA microarray. While DNA microarrays have advanced the field of genomics at an amazing rate, the instrumentation available for scanning these fluorescent microarrays has limitations. We have developed a hyperspectral DNA microarray scanner that, in conjunction with Sandia's multivariate data analysis methods, can extract more useful information from DNA microarrays. Our scanner collects the entire spectrum at each pixel, allowing us to identify and quantitatively map the concentrations of all sources of fluorescence emission. The additional information our scanner collects has several advantages over current scanners: increased sensitivity, lower detection limits, more accurate background removal, discovery and removal of impurity contributions, and the ability to monitor multiple fluorophores simultaneously.



The figure shows the spectrum and concentration map of an impurity emission discovered with the hyperspectral scanner on a commercial DNA microarray. This impurity emission appears as signal with current scanners and gives rise to unreliable data from about 1/3 of the genes.

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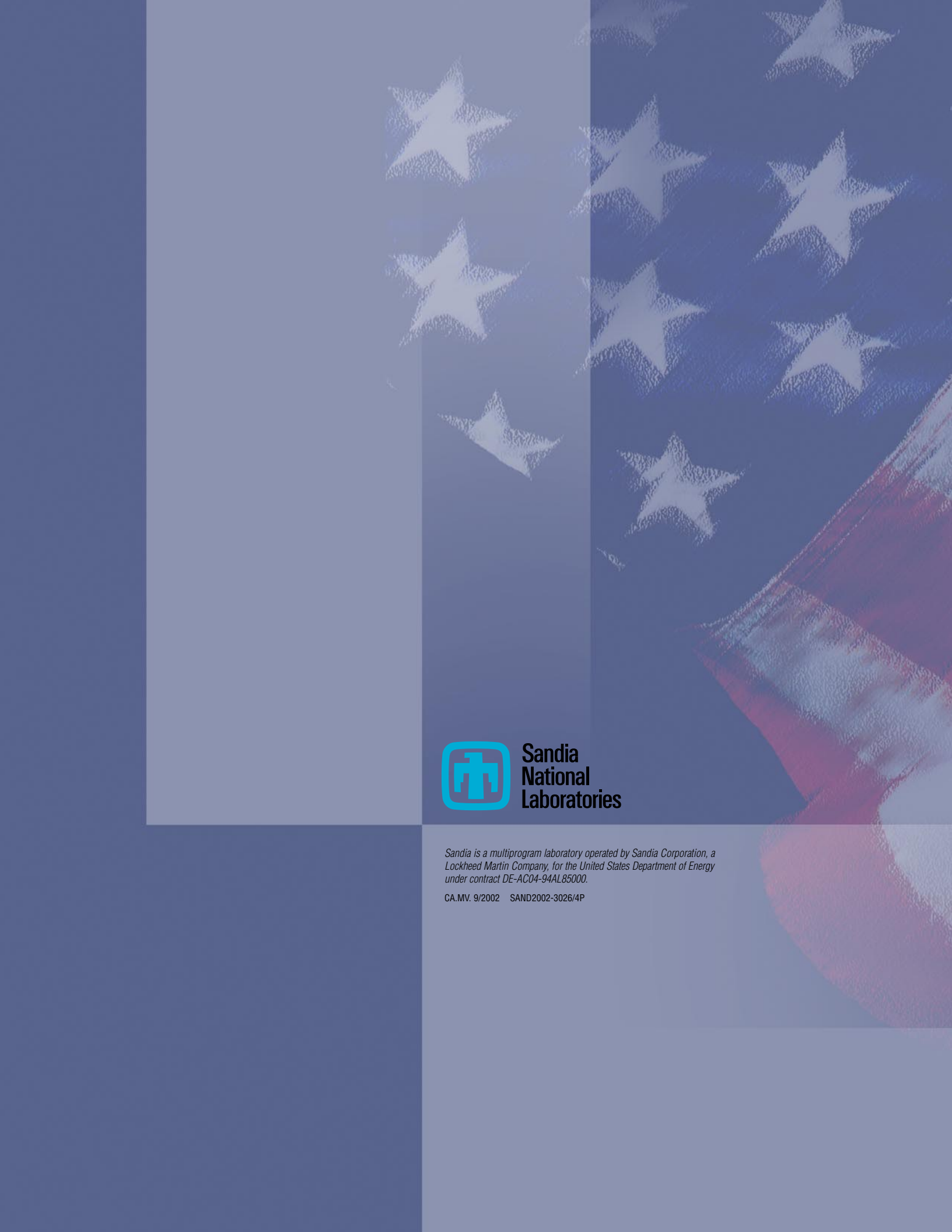

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